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Stock Status of Atlantic Salmon (*Salmo salar*) in the Cheticamp River, Cape Breton Highlands National Park, Nova Scotia, for 2004

État de la ressource de saumon atlantique (*Salmo salar*) de la rivière Chéticamp, Parc National du Cap Breton, Nouvelle-Écosse, pour 2004

Doug Landry, Gerald Chaput[1], and James Bridgland[2]

Cape Breton Highlands National Park
P.O. Box 158, Cheticamp, NS, B0E 1H0

[1] Fisheries and Oceans Canada
PO Box 5030, Moncton, NB, E1C 9B6

[2] Cape Breton Highlands National Park
Ingonish Beach, NS, B0C 1L0

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ABSTRACT

A mark and recapture experiment was conducted in the Cheticamp River, Nova Scotia, in 2004 to estimate the returns of small and large Atlantic salmon (*Salmo salar* L.). Salmon were captured, marked and released at an estuary trapnet and the catch and recaptures of previously tagged fish from creel forms in the sport fishery provided the recapture data to estimate returns. The salmon fishery in the Cheticamp River is entirely catch and release. Angling catch as declared in the completed angling forms totaled 177 fish. The trapnet was operated from July 25 to November 1 during which time 57 salmon were captured, marked and released. Creel reports from the sport fishery during August to the end of October indicated a total fishing effort of 108 hours resulting in a total catch of 20 fish of which 6 had been previously tagged. The proportion of the fish population exploited in that period was about 10.5%. The instantaneous catch rate was estimated at 0.001 fish per hour effort. Declared effort on creel forms from the sport fishery in May to July was 355 hours which results in an estimated exploitation rate of 31%. A total of catch of 67 fish was declared from that period. The total small and large salmon returning to the Cheticamp River was estimated at 409 fish (95% confidence interval: 277 to 1270 fish). Large salmon comprised 66% of the total catch of salmon at the trapnet, a proportion identical to the catches in the sport fishery. Large salmon returns in 2004 were estimated at 270 fish with less than 2.5% chance that the large salmon returns were less than 183 fish, 110% of the conservation requirement.

RÉSUMÉ

Les retours de petits saumons et de grands saumons atlantique (*Salmo salar* L.) à la rivière Chéticamp en Nouvelle-Écosse pour 2004 ont été estimés avec la méthode de capture-marquage-recapture. Des saumons ont été capturés avec un filet-trappe dans l'estuaire et marqués avant le retour à l'eau. Les déclarations de captures de saumon marqué et non-marqué dans la pêche récréative servaient de données de recapture. La pêche récréative dans la rivière Chéticamp est obligatoirement remis-à-l'eau. Le total des captures dans les déclarations de pêche se chiffrait à 177 poissons. Durant la période d'opération du filet-trappe, du 25 juillet au 1 novembre, 57 saumons ont été marqués. Un total de 108 heures d'effort de pêche et une capture de 20 saumons, dont 6 étaient porteurs d'étiquettes, ont été comptabilisé des déclarations de la pêche récréative pour les mois d'août à octobre. Le pourcentage de la population de saumon exploité durant cette période équivaut à 10,5% ou à un taux instantané de capture de 0,001 poisson par heure de pêche. L'effort de pêche inscrit sur les déclarations de mai à juillet se chiffrait à 355 heures, qui équivaut à un taux d'exploitation de 31%, et des captures de 67 saumons ont été déclarées. La remontée de petits et grands saumons pour 2004 était de 409 individus (intervalle de confiance à 95% : 277 à 1 270 individus). Les grands saumons représentaient 66% de tous les saumons manipulés au filet-trappe, un pourcentage identique à celui dans les déclarations de capture de la pêche récréative. La remontée de grands saumons a été estimée à 270 poissons avec une probabilité inférieure à 2,5% que l'abondance était moins de 183 poissons ou 110% du niveau des besoins de conservation.

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INTRODUCTION

The Cheticamp River, located at the southwestern edge of Cape Breton Highlands National Park, has its headwaters in the Cape Breton Highlands at an altitude of 500 m and flows south and westward into the Gulf of St. Lawrence. It has a total drainage area of 276 km^2. An impassable waterfall at approximately 20 km from the barachois limits access to Atlantic salmon. The total wetted area of habitat available for spawning and rearing of Atlantic salmon has been estimated at 318,915 m^2 (Boates et al. 1985).

Since 1984, exploitation of Atlantic salmon has been limited to recreational angling, which on the Cheticamp River is managed by Parks Canada under National Parks Fishing Regulations. National Parks Policy (Parks Canada 1994) permits sportfishing in National Parks but is "restricted to designated areas" (Section. 3.1.4) "where fish populations can sustain some harvest without impairing resources . . . based on continuing stock assessments" (Section. 3.2.12). In 1984 the retention of large salmon (>= 63 cm fork length) was prohibited and the catch limit for small salmon (< 63 cm fork length) was reduced to one per day and a total of five per year. Atlantic salmon adult returns to the Cheticamp River were counted in 1984 to 1989 using a counting fence located 3.75 km above the head of tide (Claytor 1996). Due to the lack of stock assessment data since the fence was discontinued in 1990, the prohibition on retention was extended in 1994 to include small salmon as well as large salmon.

By 2003, no accurate estimate of returning salmon had been available for the Cheticamp River for 14 years. During this time snorkel surveys on other park rivers showed salmon returns plummeting well below conservation requirements. Additionally, Atlantic salmon stocks elsewhere in Nova Scotia and New Brunswick were being listed as endangered both federally and provincially. In 2004, Parks Canada and the Cheticamp River Salmon Association re-established adult salmon monitoring on the Cheticamp River. This report presents the results of the 2004 adult Atlantic salmon assessment for the river.

BACKGROUND

Conservation Requirement

The conservation requirement for the Cheticamp River was determined using the procedure recommended in Anon. (1991a, b) and is summarized in Table 1. The conservation requirement of 765,000 eggs would be obtained from 166 large salmon. Biological characteristics of large salmon were summarized from creel census reports of 1978 to 1982 (Table 2). Large salmon had an average weight of just over 4.0 kg and were on average 65% female.

Stock status from 1984 to 1989

From 1984 to 1989, a counting fence was installed 3.75 km above the head of tide. Fence counts in some years are partial, due to intermittent washouts. Counts of salmon at the fence ranged from 164 to 497 large salmon and 26 to 66 small salmon (Table 3). Based on these counts and assuming that all large salmon survived to spawn, the conservation requirement for the river was

met or exceeded every year. Fish were counted through the fence as early as the week of May 14-20 to as late as October 15-21 with the majority (usually greater than 60%) of the fish counted prior to July 31 (Table 3) (Claytor 1996).

METHODS IN 2004

The 2004 assessment of the adult Atlantic salmon returns to the Cheticamp River is based on a mark and recapture experiment. A trapnet set in the tidal waters served to capture, sample and mark Atlantic salmon. The catches in the recreational fishery as reported in angler creel forms served as the recapture sample.

Trapnet Operation

A T-type trapnet was installed 1.33 km downstream of the Cabot Trail highway bridge, near the head of tide (about 1.62 km upstream of the river mouth where it empties into the ocean) at 46°39'28" North; 60°57'43" West (Fig. 1). The trapnet consisted of a box connected to the shore by a leader. The box, measuring 15.25 m long by 3 m wide and 3.7 m deep, was framed using 30mm rebar pickets with a wood frame at the top. The box and leader were constructed of knotless nylon netting, 5.25 cm stretched mesh. The leader was tapered from 3.7 m deep to the point on shore, about 15 m. The trapnet was fished at least once a day from July 26 to November 1, 2004.

All fish captured at the trapnet were identified, counted and measured for length before release. In addition, for all adult Atlantic salmon captured and released, scale samples were collected and a small, blue, individually numbered Carlin tag was attached, with fine diameter stainless steel wire, just anterior to the dorsal fin. In order to evaluate the potential tag loss, released fish were also marked by a hole punched in the upper caudal fin. The sex of adult Atlantic salmon was determined by examination of external characteristics, primarily the presence of a kype on male fish. The scale sample was taken from the standard location, the left side above the lateral line on a diagonal between the dorsal fin and anal fin.

Environmental observations recorded when the trapnet was fished included cloud cover, water level and air temperature. Continuous (one-hour intervals) water temperature recorders (VEMCO Minilog@) were installed at three points in the river in 2004: one at the trapnet, a second unit 300 meters below Faribault Brook, and a third unit in the lower portion of the river, 300 meters above the Cabot Trail bridge (Fig. 1).

Creel survey

The 2004 Atlantic salmon angling season for the Cheticamp River was from May 25 to October 31. Creel survey sheets and instructions were provided to anglers fishing the Cheticamp River (Appendix A and B). Anglers were requested to record the hours fished, location fished, and the catch by size group (small salmon, large salmon) on every fishing trip, even those for which no salmon was caught. Anglers were requested to note the presence of a tag, and if possible the tag number, on angled salmon. The creel forms were distributed during the entire fishing period,

May to October. The returned creel forms represent an incomplete but major portion of the recreational fishery in 2004. Effort was summarized in terms of hours fished, as recorded on the creel form, or in units of rod days with a rod day representing any portion of a day fished by an individual.

RESULTS

Trapnet Catches

The trapnet operated continually from July 25 to November 1, 2004. During that time, a total of 62 salmon (21 small and 41 large) were captured. Other fish captured at the trapnet in decreasing order of total catch included gaspereau (species unspecified), brook trout , striped bass, American eel, and brown trout (Table 4). It is the first recorded observation of striped bass in the Cheticamp River system. Brown trout which are not a native species to the Cheticamp River were caught in both the trapnet and by anglers. There were a few mortalities recorded at the trapnet. One small salmon was found dead in the trapnet on August 9 and a small salmon tagged mortality was found near the trap net on July 26. Other fish mortalities at the trapnet included 9 brook trout, one American eel, and 15 gaspereau. Two young merganser ducks died from entanglement in the mesh of the leader and one cormorant was found drowned in the trapnet.

Salmon were captured throughout the period of operation of the trapnet in 2004 with peak catches in late July, late September and late October (Table 4; Fig. 2). Proportionally more large salmon entered in the fall than in late July and August. A total of 57 salmon (18 small and 39 large) were tagged and released back to the river. Six of these fish, 2 small and 4 large salmon, were subsequently reported angled and the tag number reported for all but one large salmon. The days to recapture in the angling fishery ranged from 19 to 37 days.

Biological Characteristics of Atlantic Salmon in 2004

The small salmon had an average fork length of 55.6 cm, within a minimum to maximum range of 51.7 to 62.7 cm (N = 21). The large salmon had an average fork length of 77.5 cm within a minimum to maximum fork length range of 70.5 to 92.4 cm (N = 41). Sex was determined for 12 small salmon and 32 large salmon captured in September and October. During the months of July and August the external secondary characteristics were not reliably expressed and it is difficult to determine the sex of the fish. All the small salmon were males whereas 25 of 32 large salmon (78%) were female. Most (70.2%) of the salmon sampled and successfully aged for freshwater age in 2004 had a fresh water age of two years (Table 5). All the small salmon were one-sea-winter (1SW) fish. Most (92%, 33 of 36) of the large salmon were maiden two-sea-winter (2SW) salmon. Three large salmon were previous spawners; all had originally spawned as 2SW maiden salmon in 2002.

Water Temperature

Mean daily water temperatures in the fresh water portion of the Cheticamp River were rarely above 20°C in 2004 but temperatures above 20°C were observed in the first three weeks of August in the estuary (Fig. 3). The mean daily water temperature at the lower river site was cooler than the upper river site. This may be attributed to the cooling influence of Robert's Brook, located upstream of the temperature monitoring site. None of these temperatures are considered critical or lethal for Atlantic salmon.

Creel Survey Results

In 2004, 83 anglers who purchased licenses returned a total of 23 creel forms. Total reported angling activity was 177 fish. The angled fish comprised 112 for which the hook was removed by the angler, four fish for which the line was cut, 53 fish hooked and lost, and eight fish for which the activity was not described. Some creel reports were incomplete for effort. The total rod days of effort reported on the creel forms was 204 rod days with a corresponding catch of 100 salmon; 23 small salmon, 47 large salmon and 30 of unspecified size (Table 6). The largest effort (rod days) and catch were recorded in June (Table 6). There were fewer creel forms with hours of angling effort and catch reported. A total of just under 463 hours of angler effort were reported during which time 87 salmon were caught, 20 small, 37 large and 30 size unspecified (Table 7). Catch per unit of effort (rod days or hours) was highest in June and July of 2004 (Tables 6, 7; Fig. 4).

Population Estimate

In 2004, the first salmon was tagged and released on 26 July. From that date until 31 October, a total of 57 salmon were marked (M) and released to the river. In the angling fishery, a total of 20 fish were reported caught (C), including six recaptures (R) of the 57 previously marked fish. The exploitation rate for August through October was estimated at 0.105 (ER = R/M = 6/57) or 10.5% of the marked population. This exploitation rate was the result of 108.25 hours of declared effort and equates to an instantaneous catch rate of 0.001 fish per hour (Appendix C). The estimated return of salmon in August to October 2004 is 190 fish.

Since no salmon were tagged during the May to July portion of the season, the proportion of the population exploited by the recreational fishery in the early portion of 2004 is estimated using the instantaneous catch rate from August through October applied to the declared effort from May to July. During this period, a total of 354.5 hours of effort were reported on the creel forms. This results in an exploitation rate for this portion of the season of 0.310 (Appendix C). At a declared catch of 67 fish during the May to July period, the point estimate of the returns of salmon to the Cheticamp River in May to July is 219 fish. The total return for 2004 is estimated as the sum of the early and late returns, 409 fish. From the trapnet catches, 66.1% of the fish were large salmon (Table 8). As a result, 270 large salmon were estimated to have returned to the Cheticamp River in 2004 (409 small and large salmon multiplied by 66.1% large salmon).

Confidence Interval

The uncertainty in the estimates of the exploitation rate in the fall was described using a Bayes probability profile as described by Gazey and Staley (1986). The confidence intervals for the exploitation rates and the return estimates are calculated from the probability profiles as the proportion of the area under the curve corresponding to the confidence region of interest. The 95% confidence region for the fall exploitation rate, based on six recaptures of the 57 tags available, corresponds to the interval 0.033 to 0.167 (Fig. 5). For the May to July portion of the run, the 95% confidence region for the exploitation rate was 0.103 to 0.450 (Fig. 5).

The returns of Atlantic salmon to the Cheticamp River in 2004 were estimated to have been about 410 fish, with a 95% confidence region of 277 to 1270 fish (Fig. 5). Slightly more fish were estimated to have returned during May to July (mode = 221 fish) then during August to October (mode = 194 fish) (Fig. 5). There is greater than 97% chance that at least 183 large salmon returned to the river in 2004 (lower confidence interval of 277 multiplied by 66.1%).

DISCUSSION

Assumptions of the Estimation Model

The estimates of the catch rates and the returns are based on a mark and recapture experiment. The assumptions of this method for the Cheticamp River experiment of 2004 are described below.

1) Salmon tagged and released have the same probability of capture in the angling fishery as untagged salmon. This assumes that handling of fish at the trapnet does not affect the subsequent vulnerability to capture in the recreational fishery. If tagging and handling makes tagged fish less susceptible to capture in the recreational fishery, then the exploitation rate would be underestimated and the returns over-estimated. There is no information available from the 2004 experiment for or against this assumption.
2) There is no tagging or handling mortality or loss of tags prior to the recreational fishery. If tagged fish die from tagging and handling or tags are shed prior to the recreational fishery and this loss is not accounted for, then the exploitation rate would be underestimated and the returns would be overestimated.
3) All tagged fish and untagged fish captured in the recreational fishery are accurately reported. The creel forms with the most complete information (hours of effort and catch) were used in the estimates of returns. If tagged fish are under reported relative to untagged fish (i.e. tags not seen and fish reported as untagged), then the exploitation rates would be underestimated and the returns would be overestimated.
4) Small salmon and large salmon are captured at similar rates in the recreational fishery. Because of the small sample sizes, the recaptures of small and large salmon are grouped. This assumption could be verified in the future if more tags are applied and recaptured.
5) Catch rates (instantaneous catch per hour) derived from the fall period (August to October) are similar to those of the early period (May to July). Because no salmon were tagged and released prior to the end of July, it was assumed that the catch rates in the fall were similar

to those of the early period. If catch rates in the early period are higher than those in the fall, then the exploitation rate for the early period would have been underestimated and the returns for the early period would have been overestimated. This assumption could be verified in subsequent years by tagging salmon throughout the run and calculating catch rates for different periods of the fishery.

Stock Status in 2004

Based on the mark and recapture experiment and the declared catches in the recreational fishery, there is a greater than 97% chance that there were at least 183 large salmon returning to the Cheticamp River in 2004. The observations from the catches at the trapnet indicated that the large salmon were mostly female (78%). As a result, there is a very high probability that the conservation requirement of 166 large salmon was met or exceeded in 2004.

Recommendations for 2005

The trapnet and creel survey projects of 2004 demonstrated a feasible approach for estimating returns and exploitation of Atlantic salmon in the Cheticamp River. The experiment depends upon a reliable sampling program, as for example creel forms, of the recreational fishery. A fishery independent estimate, as would be obtained using a series of marking and recapture trapnets in the estuary, may be difficult to obtain in the Cheticamp River because the estuary is relatively small and there are few suitable trapnet locations. The intention is to obtain an estimate of abundance by handling the minimum number of fish. Improvements to the project in 2005 follow:

1) The estuary trapnet should be operational as soon as possible after mid-May in order to sample and tag the entire run to the river. This will provide information on run-timing, fish movement upstream, catch rates in the recreational fishery throughout the year, and biological characteristics.
2) The creel survey forms should be passed out to each angler as they purchase their license. This will provide more complete information on catch, effort and increase the probability of recording captures of tagged fish in the recreational fishery. Anglers who are frequent users of the Cheticamp River should be prompted to complete log books.

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Table 1. Calculation of the conservation requirement in terms of eggs and large salmon equivalents for the Cheticamp River.

	Estimate	Reference
Habitat area for salmon (m^2)	318915	Boates *et al.* 1985
Conservation egg deposition rate (eggs / m^2)	2.4	Anon. 1991a,b
Conservation egg requirement (eggs)	765396	
Fecundity (eggs / kg)	1764	Elson 1975
Average weight (kg)	4.02	See Table 2
(annual min-max)	(3.6 – 4.4)	
Proportion female	0.65	See Table 2
(annual min-max)	(0.55 – 0.81)	
Conservation requirement	166	
(large salmon, min – max)	(122 – 222)	

Table 2. Biological characteristics of large salmon (>= 63 cm fork length) from the Cheticamp River as recorded in creel census reports from 1978 to 1983 (Peterson *et al.* 1987).

	Male		Female		Sampled	Mean
Year	N	%	N	%	for weight (N)	weight (kg)
1978	8	19.0	34	81.0	48	4.25
1979	7	39.0	11	61.0	19	4.40
1980	31	34.0	60	66.0	88	4.24
1981	21	45.0	26	55.0	52	4.08
1982	28	41.0	41	59.0	78	3.56
1983	29	35.0	55	65.0	112	3.98
Overall	124	35.3	227	64.7	397	4.02

Table 3. Counts of small and large salmon and proportion of the total enumerated before July 31, at the counting fence in the Cheticamp River, 1984 to 1989 (data from Hoffman and Bridgland 1993 and Claytor 1996).

	Total count		Proportion counted before July 31	
Year	Small salmon	Large salmon	Small salmon	Large salmon
1984	55	190	0.89	0.92
1985	26	164	0.50	0.64
1986	64	497	0.65	0.88
1987	48	247	0.66	0.75
1988	39	180	0.69	0.80
1989	66	323	0.61	0.80

Table 4. Catch of fish by species and month at the trapnet in the estuary of the Cheticamp River, July 25 to November 1, 2004.

	Month					
Species	July	Aug.	Sept.	Oct.	Nov.	Total
Atlantic salmon (*Salmo salar* L.)	14	11	16	20	1	62
Brook trout (*Salvelinus fontinalis* M.)	5	5	8	7	0	25
Brown trout (*Salmo trutta* L.)	0	1	0	0	0	1
Gaspereau (*Alosa* sp.)	7	23	20	12	0	62
Striped bass (*Morone saxatilis* W.)	0	4	0	0	0	4
American eel (*Anguilla rostrata* L.)	0	1	0	0	0	1

Table 5. River and sea age composition of Atlantic salmon sampled at the trap net in the Cheticamp River, 2004. 1SW and 2SW maiden refers to fish on their first spawning migration to the river. 2-4 Repeat refers to fish which are on the second spawning migration of a total sea age of 4 years and which had first spawned as a 2SW salmon. Unknown refers to scales which were partially regenerated and from which either fresh water age, sea age or both could not be determined.

	Fresh water age (years)			
Sea age	2	3	Unknown	Total
1SW maiden	12	5	3	20
2SW maiden	20	8	5	33
2-4 Repeat	1	1	1	3
Unknown	0	0	4	4
Total	33	14	13	60

Table 6. Effort (rod days), corresponding catch of Atlantic salmon by size group (small, large, unspecified), and catch per unit of effort (CPUE) for the Cheticamp River, based on volunteer creel surveys.

	Effort	Catch				CPUE
Month	(Rod days)	Small (<63 cm)	Large (≥63 cm)	Unknown Size[1]	Total	(Catch per rod day)
May	1	0	0	0	0	0.000
June	56	6	22	6	34	0.607
July	44	6	15	10	31	0.705
June/July	18	0	0	12	12	0.667
August	25	4	4	0	8	0.320
September	26	4	1	0	5	0.192
October	34	3	5	2	10	0.294
May to July	119	12	37	28	77	0.590
Aug. to Oct.	85	11	10	2	23	0.250
Total Season	204	23	47	30	100	0.490

[1] Unknown size of fish because that information was not provided in the angler reports.

Table 7. Monthly effort (hours), catch of Atlantic salmon by size group (small, large, unspecified), and catch per unit of effort (CPUE) for the Cheticamp River based on volunteer creel surveys in 2004. Total catch differs from Table 6 because not all angler returns included hours fished.

Month	Effort (Hours)	Catch				CPUE (Catch per hour)
		Small (<63 cm)	Large (≥63 cm)	Unknown Size[1]	Total	
May	2	0	0	0	0	0.000
June	218	6	18	6	30	0.138
July	102.5	5	10	10	25	0.244
June/July	32	0	0	12	12	0.375
August	29	2	3	0	5	0.172
September	33.58	4	1	0	5	0.149
October	45.67	3	5	2	10	0.219
May to July	354.5	11	28	28	67	0.188
Aug. to Oct.	108.25	9	9	2	20	0.189
Total Season	462.75	20	37	30	87	0.188

[1] Unknown size of fish because that information was not provided in the angler reports.

Table 8. Proportion small and large Atlantic salmon from the Cheticamp River in 2004 in comparison to size proportions from 1984 to 1989. The ratio of small to large salmon for creel survey is based on fish landed by anglers for which the hook was removed and the size of the fish was indicated. The catch numbers differ from Table 6 and 7 because all creel reports were used in this analysis, even if effort had not been recorded.

Sampling method	Year	Small	Large	% Small	% Large	Total Fish
Trap Net	2004	21	41	33.9	66.1	62
Creel Survey	2004	28	54	34.1	65.9	82
Counting Fence	1984-1989	298	1601	15.7	84.3	1899

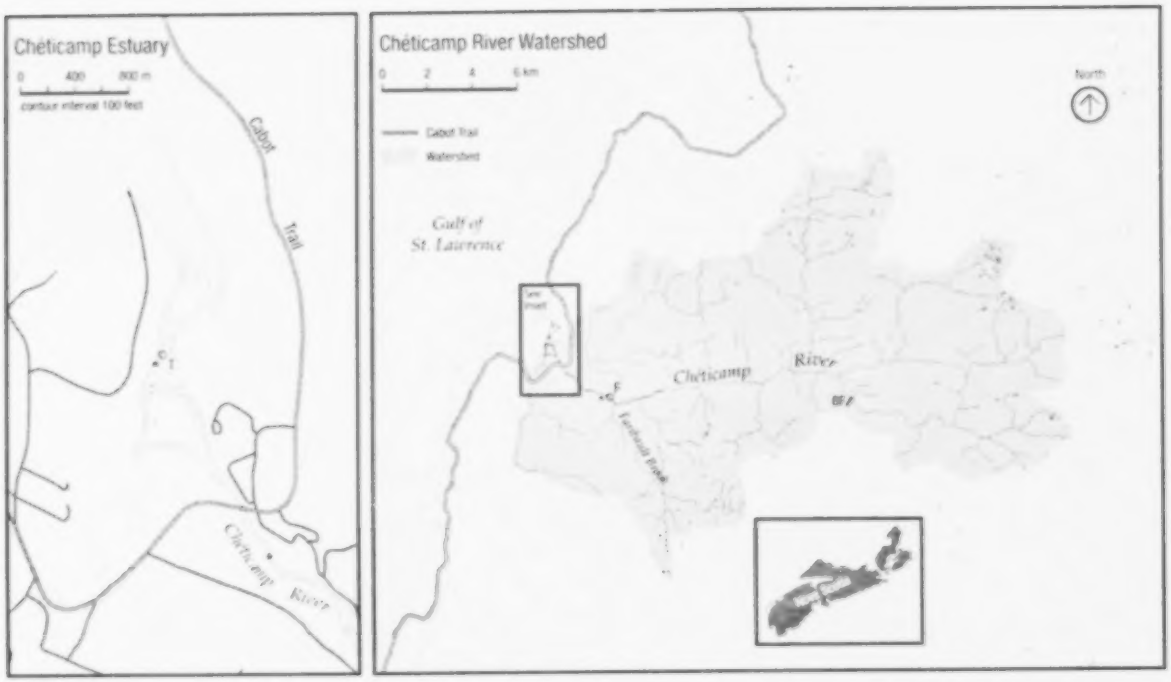
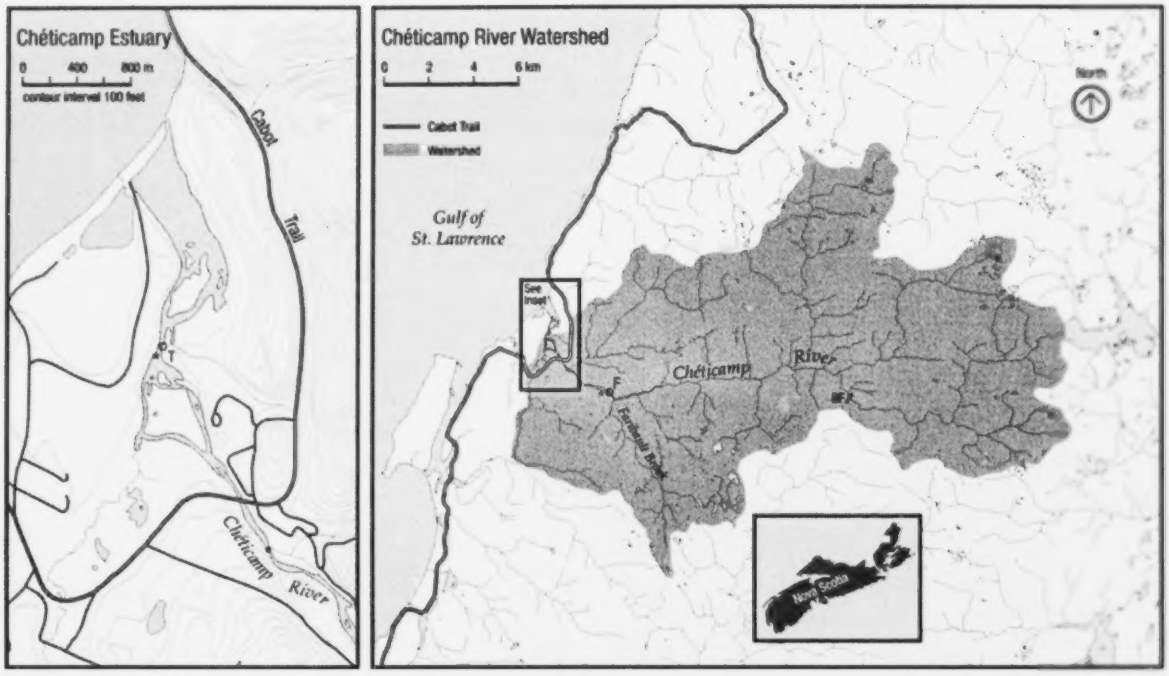


Figure 1. Cheticamp River, watershed and estuary. BF indicates barrier falls limiting upstream movement of salmon. F shows location of fence operated from 1984 to 1989. T is location of the trap net operated in 2004. Asterisks (*) indicate the locations of the temperature recorders in 2004.



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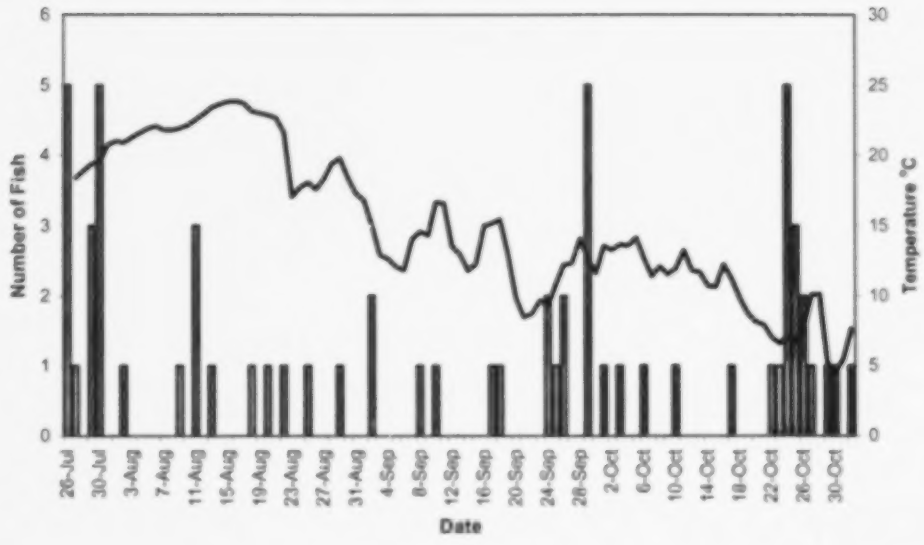

Figure 2. Daily Atlantic salmon catches and mean daily water temperature at the trap net in the estuary of the Cheticamp River, July 26 to November 1, 2004.

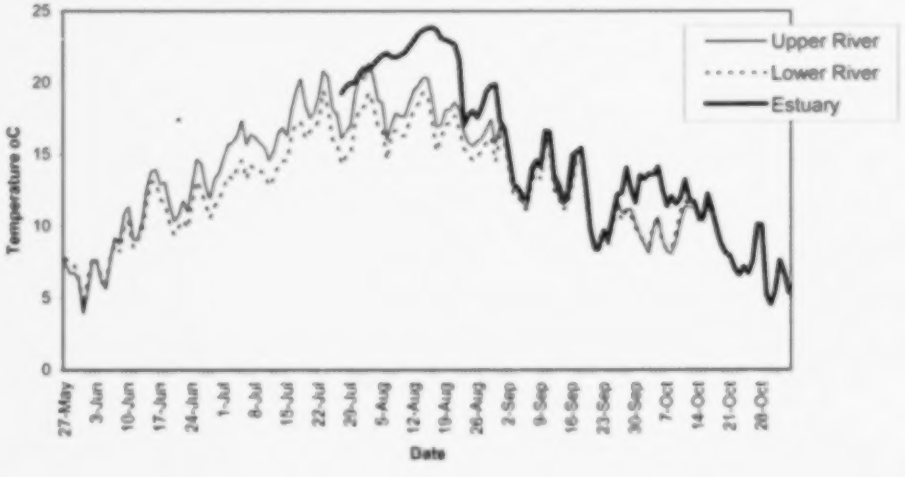

Figure 3. Mean daily water temperatures from the Cheticamp River as recorded at three locations from late May to the end of October, 2004.

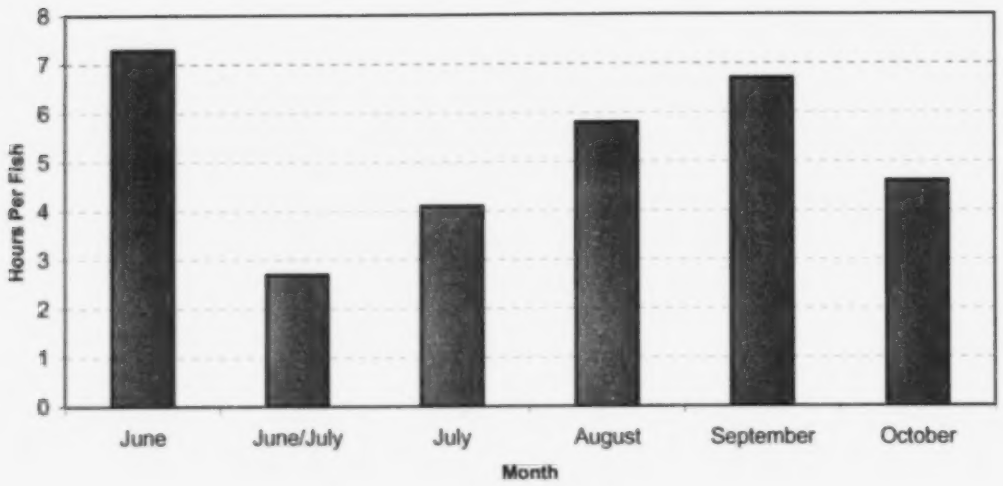

Figure 4. Monthly angling success, expressed as the number of hours required to catch one fish, by month, in the Cheticamp River in 2004.

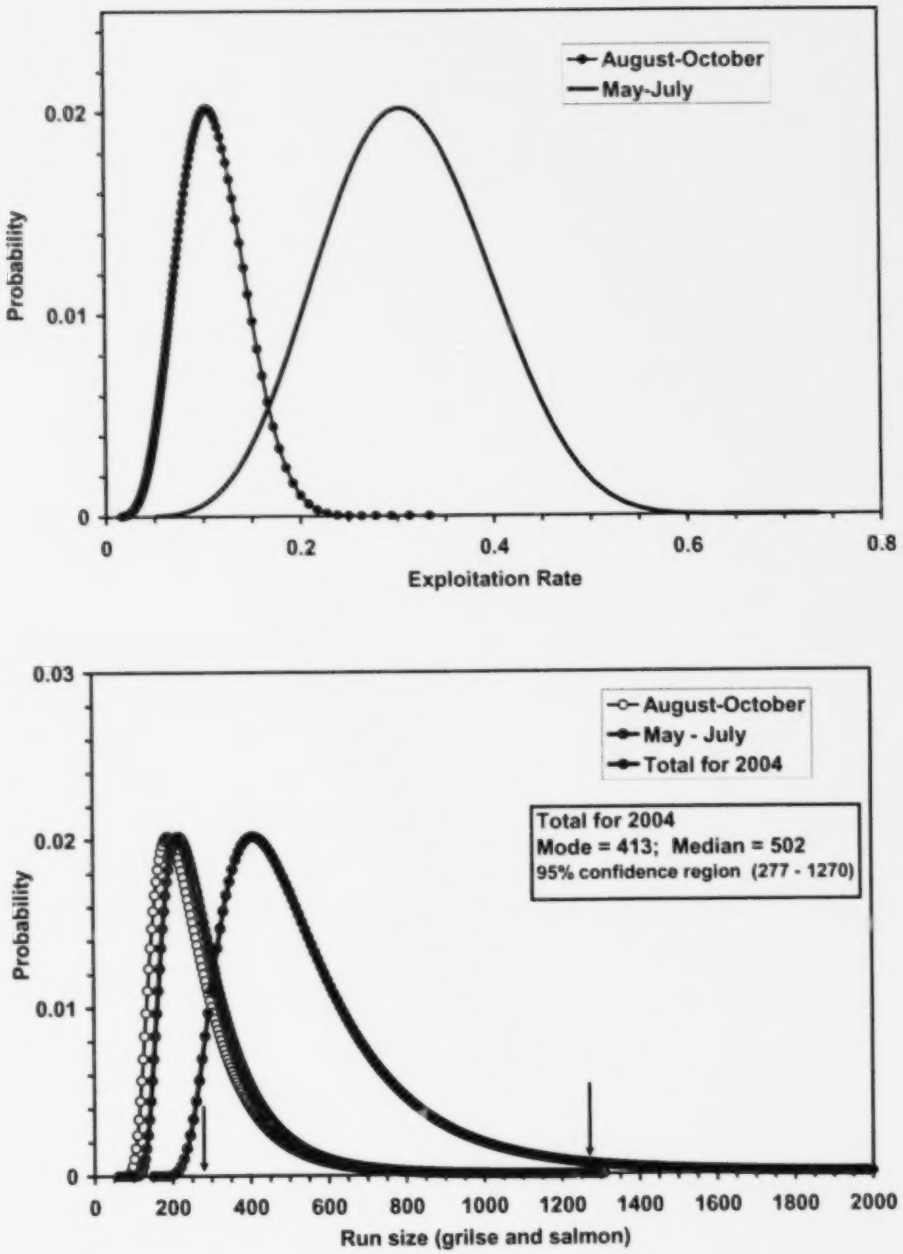

Figure 5. Estimated exploitation rates in the May to July and August to October fishing seasons (upper panel) and the estimated return of Atlantic salmon (both size groups) (lower panel) to the Cheticamp River, 2004. Arrows demarcate the lower and upper bounds of the 95% confidence interval.

Appendix A. Angler creel census log survey sheet instructions.

Canada

CheticampRiver Salmon
Association
P.O.Box 1022, Cheticamp, Nova
Scotia
B0E 1H0

LOG SHEET FOR SALMON ANGLERS – INSTRUCTIONS

- The Cape Breton Highlands National Park, in collaboration with the Cheticamp Salmon Association, have began a study on the Cheticamp River to assess the run-size of the Atlantic salmon population. During the 2004 Atlantic salmon fishing season log sheets will be handed out to all anglers fishing the Cheticamp River system. These log sheets will serve two purposes: 1) A creel census will be performed to determine a catch per unit effort of angling on the river and 2) A salmon trap net, located in the river's estuary, will be used to capture returning fish. The adult salmon are tagged and released back into the water. We are asking all anglers to **please help us to gather management data and report** any fish that are caught, tagged or untagged.
- Please make an entry for each fishing trip whether or not you had any catch. **Please record all fishing trips, even if you had no catch.** This information is just as important as that for successful trips.
- Please indicate the number of hours fished. This does not include the time spent walking site to site. Catch per unit effort (CPUE) of our creel survey will be presented as number of fish caught per rod day, as well as the number of fish caught per hour. This will give us a more accurate account of the river's fish population.
- Grilse (1SW) are considered fish with a fork length of less than <63cm and salmon (MSW) have a fork length greater than or equal to ≥63cm. Fork length refers to the distance from the tip of the snout to the fork in the tail. See diagram below.
- The "released or lost" columns are defined as follows:
- RH = Removed hook - The fish is landed and the hook removed before releasing the fish.
- CL = Cut line - The fish is not handled but the leader is intentionally cut.
- LO = Lost - The fish was hooked but lost after some effort to land the fish.
- Captured fish at the trap will be tagged using **carlin tags**. A plastic tag is attached to the front of the fish's dorsal fin that will contain a number for each individual fish. Please record this number on the log sheet and **leave the tag on the fish**.
- This creel survey is only applicable to angling done on the **Cheticamp River**. Please indicate the name of the pool or section of river that the fish was caught.
- Comments column: Use the comments column for any comments you may have on the fishery or something about the fish that was caught. This may include anything from high water levels noticed to net scars found on the fish.
- Once the log sheet is competed or you are moving out of the area, please drop off the log sheet at the Park entrance Visitor Information Centre, warden office, or the drop off box located at the beginning of the "Trous De Saumons" trail. New log sheets can also be picked at each site to continue your daily record. **Thank you for your assistance in this important study.**

Appendix B. Angler creel census survey sheet.

Year _____

Name _____

Cape Breton Highlands National Park
Cheticamp River Salmon Creel Survey

Page Number _____

Address and Phone Number
_____
_____
_____

These columns must be filled out each time you go fishing			Salmon and Grilse Released or Lost						
Month	Day	Number of Hours Fished	Grilse (G) or Salmon	Released or Lost			Tag Number (If Present)	Location Caught (Pool Name)	Comments
				RH	CL	LO			

Please Record All Fishing Days Even If You Had No Catch

RH - Remove hook
CL - Cut line
LO - Lost

Appendix C. Derivation of instantaneous catch rates and season specific exploitation rates in the Cheticamp River Atlantic salmon fishery, 2004.

In fisheries, catch is generally a function of effort. If it is assumed that the probability of a fish being caught per unit of effort is the same for all fish in the stock or population, then as effort increases, catch increases and the proportion of the population exploited (exploitation rate) increases (Fig. C-1). The instantaneous fishing rate is a linear function of effort but the relationship between catch (or exploitation rate) and effort is not linear.

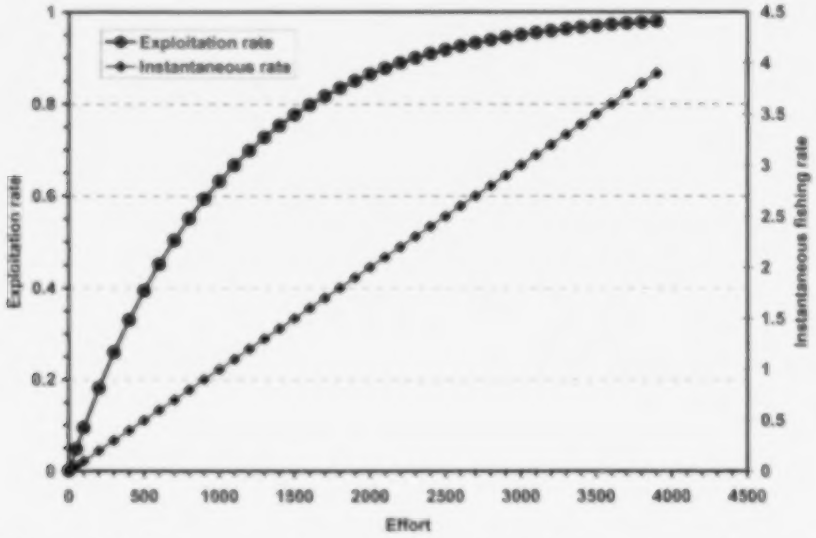

Figure C-1. Relationship between exploitation rate, total instantaneous fishing rate and effort when the instantaneous rate of fishing (probability of capture of an individual fish) is 0.001 fish per unit of effort.

The conversion from instantaneous fishing rate to exploitation rate is defined by the standard survival equation (Ricker 1975):

$$N_t = N_0 e^{-Z}$$

where N_t = fish alive at time t
N_0 = fish alive at time zero
Z = instantaneous fishing rate

The proportion of the fish <u>not</u> caught is N_t/N_0. Therefore, the proportion of the fish captured (ER = Exploitation Rate) is:

$$ER = 1 - N_t/N_0$$
$$= 1 - e^{-Z}$$

The exploitation rate can be estimated from mark-recapture data. It is equal to the ratio of recaptures of previously marked fish (R) to the total marked sample (M). For the Cheticamp River experiment in 2004, ER = 6 / 57 = 0.105 for the fish marked and recaptured from August to October 2004. This is the proportion of the available population exploited by the anglers that reported their catch and effort in creel forms.

With an exploitation rate of 0.105, and recalling that $ER = 1 - e^{-Z}$, then

$$0.105 = 1 - e^{-Z}$$

and the instantaneous catch rate for the Cheticamp from August through October is

$$Z = -\ln(1 - 0.105)$$
$$= 0.11123$$

This Z estimate applies to the total hours of effort recorded in the creel forms during that period of fishing, therefore

Z (per hour) = 0.11123 divided by the declared hours of effort for August-October
= 0.11123 / 108.25 hours
= 0.001027 fish per hour

Under the assumption that on average this instantaneous catch rate applies to the effort at any time during the angling season, then the exploitation rate for the fishery for May to July can be calculated based on the recorded effort for that period.

In May to July, a total of 354.5 hours of effort were reported which equates to an instantaneous catch rate for that period of:

$$Z = 354.5 * 0.001027 \text{ fish per hour}$$
$$= 0.364$$

and an exploitation rate of:

$$ER = 1 - e^{-Z}$$
$$= 1 - e^{-0.364}$$
$$= 0.305$$

Run size estimates for the early and late periods are calculated using the reported catch and the estimated exploitation rates for each period.

Period	Declared Catch (C)	Exploitation Rate (ER)	Estimated Return (C/ER)
May to July	67	0.305	219
Aug. to Oct.	20	0.105	190
Total May to Oct			409